

Technical and Market Aspects of Innovative Storage Opportunities

U.S. Department of Energy
Energy Storage Systems Research
Annual Peer Review
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Agenda

- **Previous Work**

- Phase I: broad, “out-of-the-box” scenarios
- Phase II: market opportunity quantification & screening

- **Phase III: Current Work**

- Combined application:
 - energy price arbitrage, plus
 - T&D deferral

- **Next Steps**

Phase I

Investigate Nine “Stretch Scenarios”

- High-level inventory of innovative energy storage “market opportunities”
- “Best” Five selected for further investigation
 - Enhanced Environmental Externalities
 - Power Price Volatility
 - Customer Siting for Transmission and/or Distribution System Benefits
 - Storage System Packaging Breakthroughs
 - Combined Heat and Power Output Smoothing

Phase II

Identify “Most Promising” Storage Market Opportunity

- Identify and characterize “most promising” market opportunity for further study
- Detailed evaluation of the five market opportunities from Phase I
 - 12 “versions”

Phase II

Market Opportunity Screening

High T&D Value PLUS High Energy Price Volatility

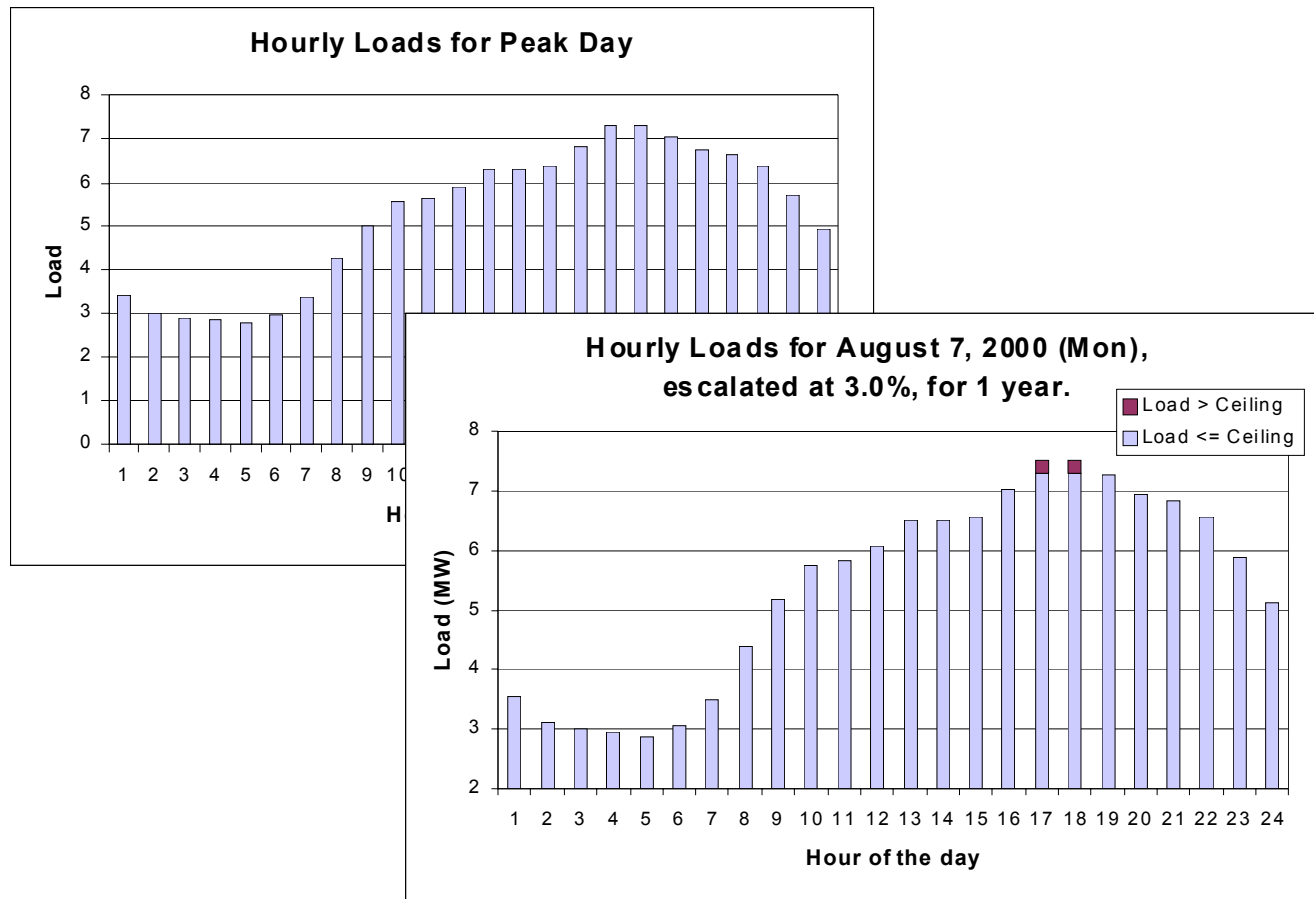
1. Storage value metric = \$218/kWh (five hours)
2. Power/Output Capacity Potential
= 10% of load growth of 240 GW/yr = 24 GW/yr
3. Storage Capacity Potential = five hours * 24 GW =
120 GWh/yr
4. 120 GWh * \$218/kWh = \$26 Billion

Phase III – FY02-03

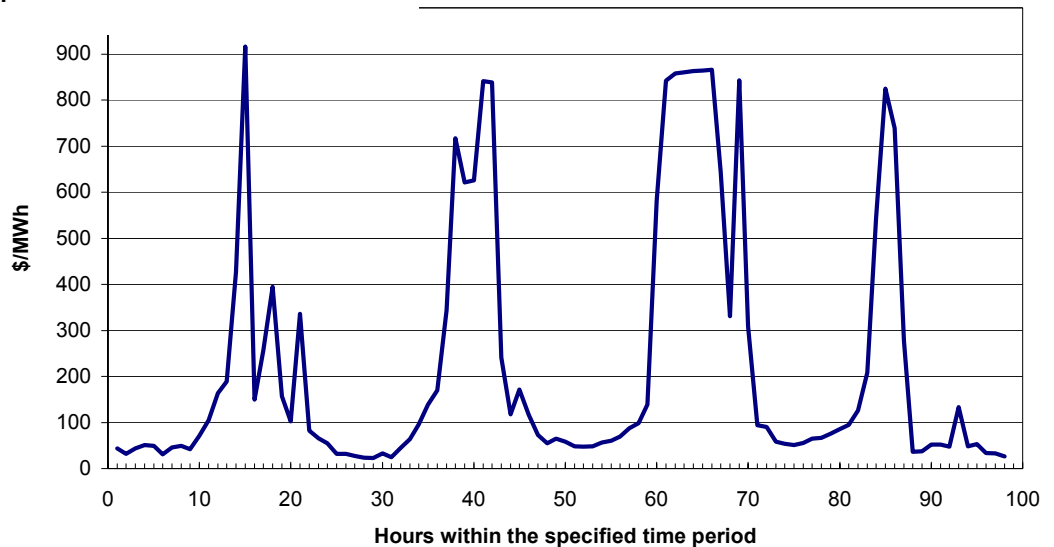
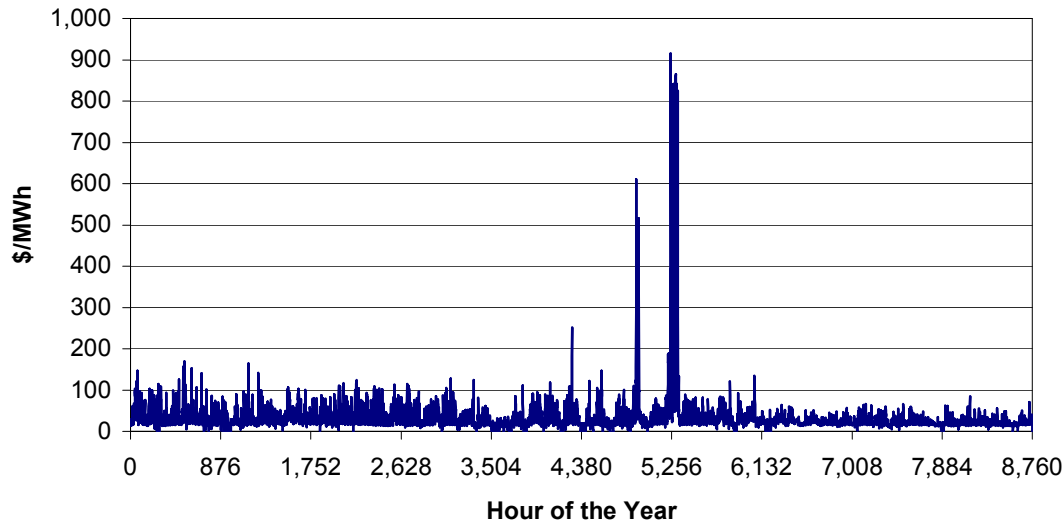
- The Value Proposition
 - Two complementary applications using one storage system
 1. High Energy Price Volatility => Arbitrage
 - Ten Years
 2. T&D Upgrade Deferral
 - One Year Only;
 - Utility: a) data b) concurrence about benefits
- The Storage System “Product”
 - technical requirements
 - storage vendor input

T&D Deferral with Storage

- Storage discharge duration to clip peak demand on the grid, on the peak load day.

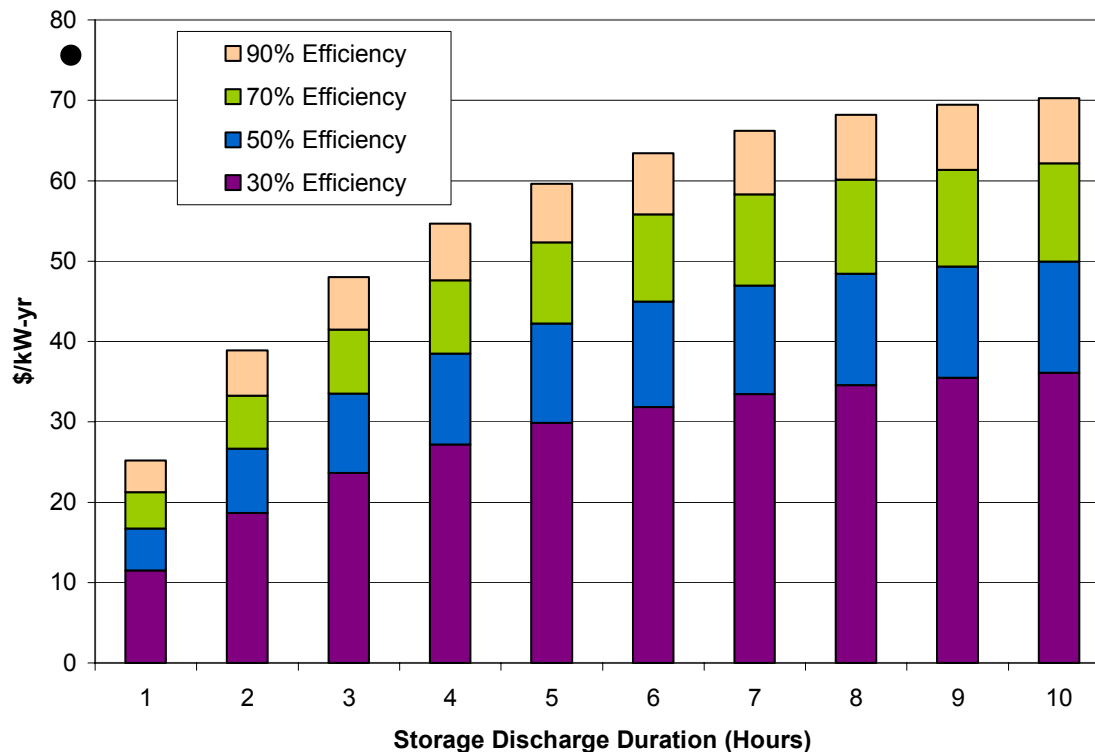


PJM Energy Price Volatility (2001)



Net Annual Arbitrage Benefits

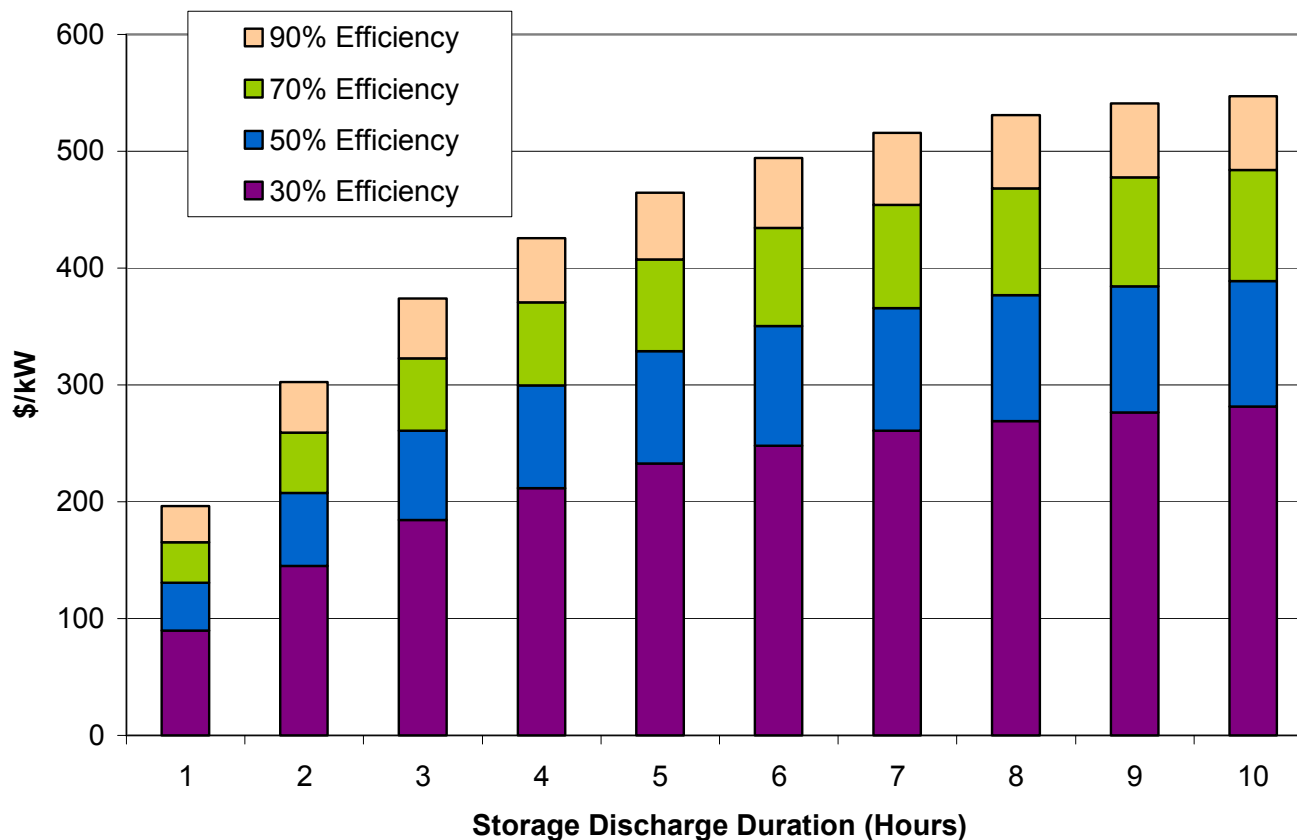
- 1¢/kWh variable maintenance



Multiply by 7.8 to convert to Net Present Value for ten years,
for 2% price escalation and 8% discount rate.

Net Lifecycle Arbitrage Benefits

- Ten years: 2% price escalation, 8% discount rate



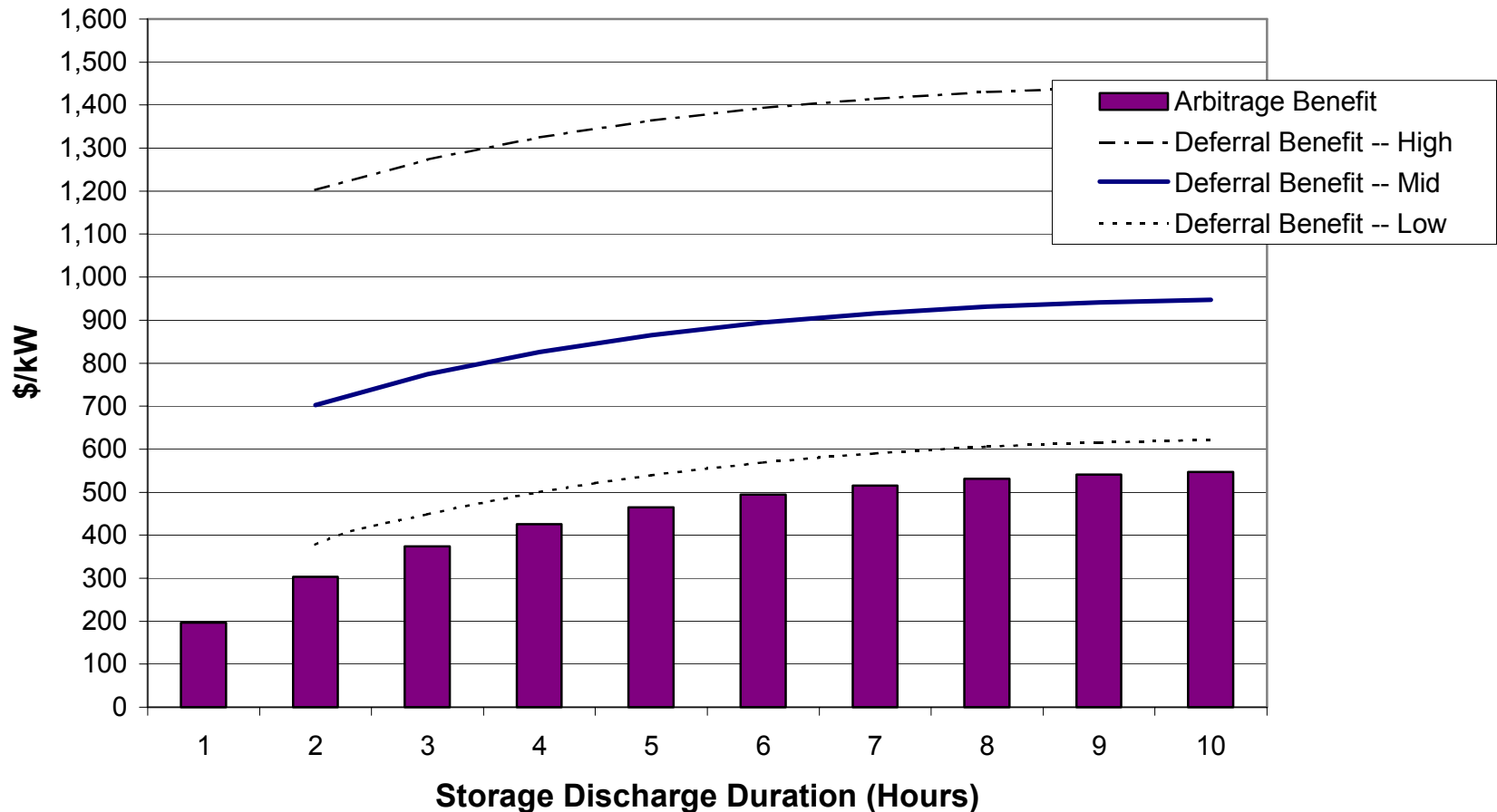
T&D Deferral Benefits (one year)

- Case 1.a. 2002 Service Upgrade to Long Beach Island, New Jersey (Conectiv)
 - 69kV service to island \$5.3 Million
 - new island substation \$3.8 Million
 - 12.47 kV Feeders \$1.5 Million

Item	Value	Note
T&D Investment	\$10.6 Million	
Annual Deferral Benefit	\$837,400	\$10.6 Million * .079 cost-of-capital
Peak Load Growth 2002	2.1 MW	
Deferral Benefit from Storage	\$399 / kW	\$837,400 / 2,100 kW load growth

Bottom Line: 1 year T&D deferral worth \$399/kW of storage

Arbitrage plus T&D Deferral Total Net Benefits (90% efficiency)



Market Vision

- Product offerings from two or more vendors:
 - suitable for arbitrage plus T&D deferral
 - no technical barriers exist
- Utilities and/or “Market Aggregators” use those products
- Market Potential (annual)
 - a portion of load growth (no embedded load)
 - 4 GW, 12 GWh, \$4 Billion (all per year)

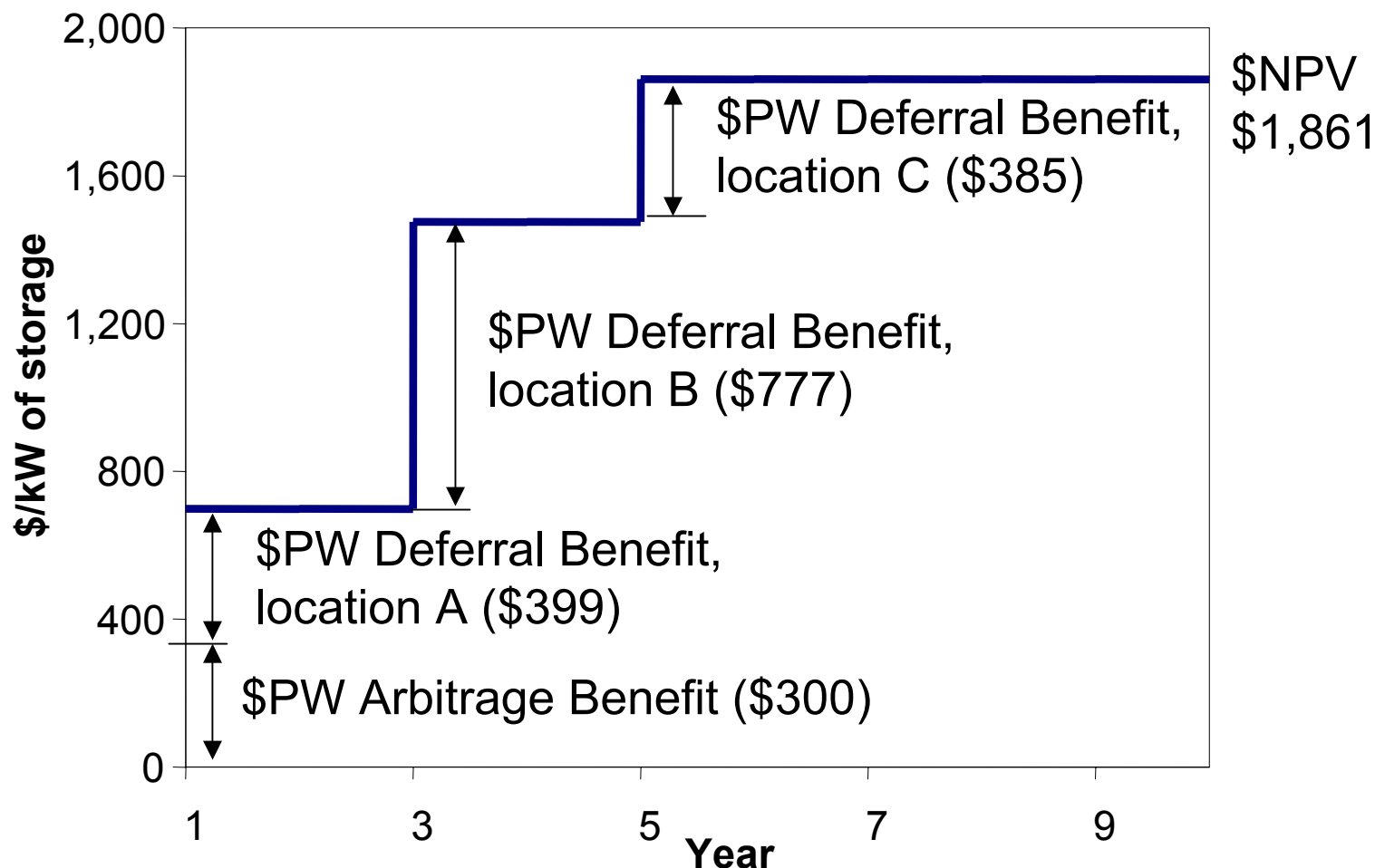
Notable Storage Industry and Stakeholders' Feedback

- Vendors are engaged, interested, excited...
 - storage cost commensurate with benefits
 - some vendors already pursuing T&D deferral
- Market Vision and Application Valuation influencing California Energy Commission
- Arbitrage benefits similar to TVA estimates
- Conectiv interest in hosting demo
- ESA members generally enthusiastic

Many Possible Next Steps

- Demonstrations
- Validate Sizing Methodology
- Validate Benefits Estimation Methodology
- Standardized Storage Product (definition)
- Plug and Play Modules
 - Warranties

Value of Portability (\$PW)



Interest Rate 7.9%
Discount Rate 10.0%

Value of Portability Year 1

Storage Plant Capacity 210

Interest Rate 7.9%

Discount Rate 10.0%

Year #	1
Load Growth Rate	2.0%
Base Capacity (MW)	10.5
Project Cost (\$Million \$Current)	1.06

One Year Deferral Value

\$Current 83,740

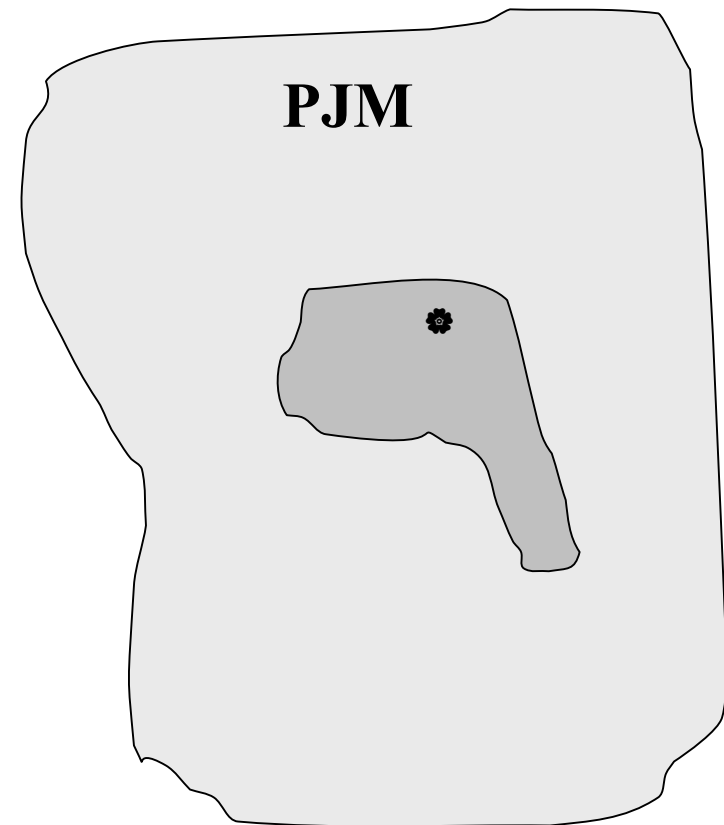
\$ PW 83,740

Load Growth (kW) 210

Storage Deferral Value

\$/kW-yr, \$Current 399

\$/kW-yr, \$PW 399



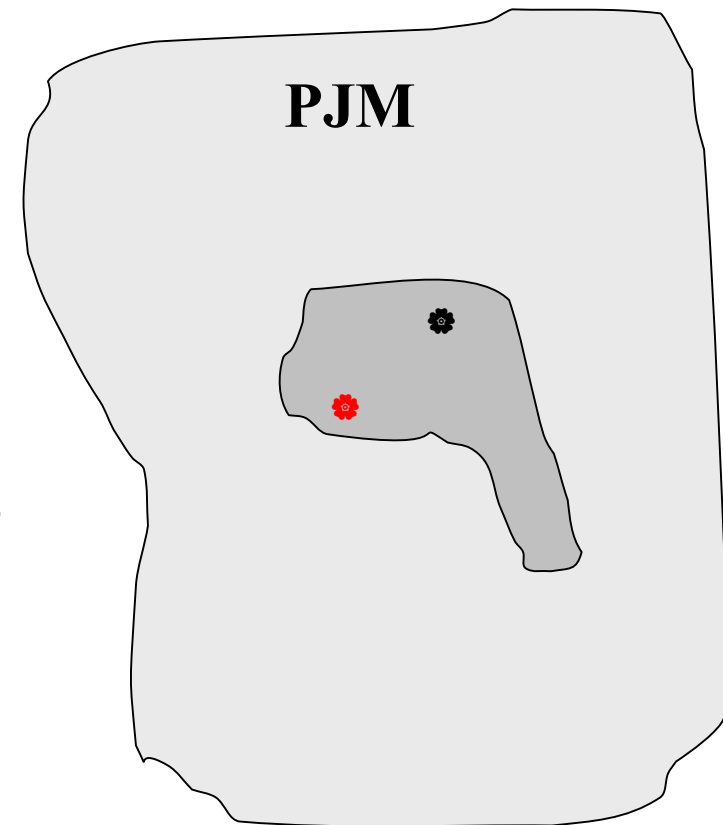
Value of Portability Second Year

Storage Plant Capacity 210

Interest Rate 7.9%

Discount Rate 10.0%

Year #	1	3	
Load Growth Rate	2.0%	2.0%	
Base Capacity (MW)	10.5	10	
Project Cost (\$Million \$Current)	1.06	2.5	
One Year Deferral Value			<u>Total</u>
\$Current	83,740	197,500	281,240
\$ PW	83,740	163,223	246,963
Load Growth (kW)	210	200	
Storage Deferral Value			<u>Total</u>
\$/kW-yr, \$Current	399	940	1,339
\$/kW-yr, \$PW	399	777	1,176



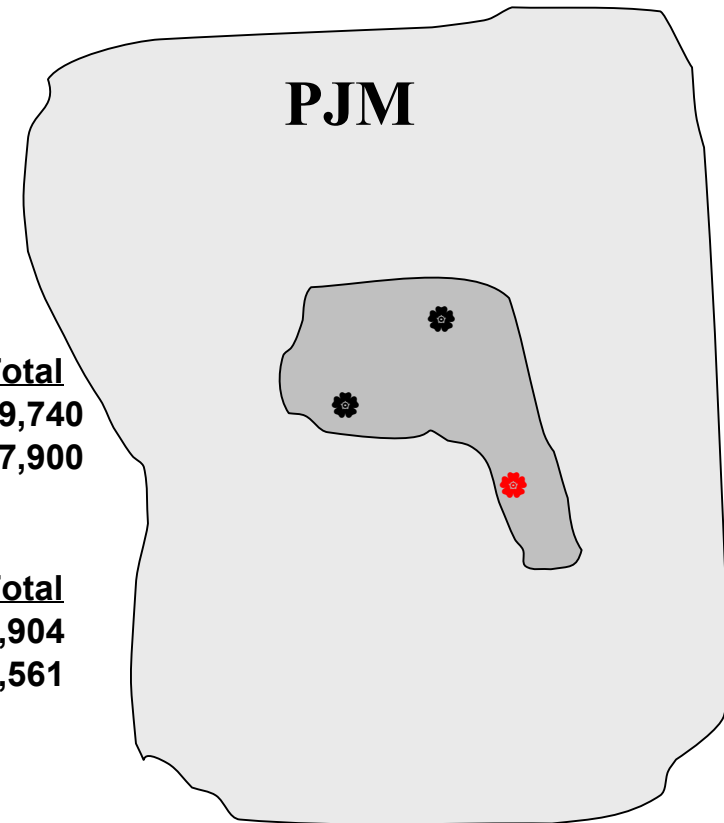
Value of Portability Third Year

Storage Plant Capacity 210

Interest Rate 7.9%

Discount Rate 10.0%

Year #	1	3	5	
Load Growth Rate	2.0%	2.0%	2.5%	
Base Capacity (MW)	10.5	10	8	
Project Cost (\$Million \$Current)	1.06	2.5	1.5	
One Year Deferral Value				<u>Total</u>
\$Current	83,740	197,500	118,500	399,740
\$ PW	83,740	163,223	80,937	327,900
Load Growth (kW)	210	200	200	
Storage Deferral Value				<u>Total</u>
\$/kW-yr, \$Current	399	940	564	1,904
\$/kW-yr, \$PW	399	777	385	1,561



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